torsional deformation is not sufficiently accurate to justify elaborate precautions against bending moments, although it is not difficult to devise quite simple apparatus for making these angular measurements. These simpler means are somewhat overlooked by Mr. Popplewell, but an excellent account is given of the more elaborate and accurate instrument designed by Mr. Coker.

We are glad to find that our author, while describing several of the standard forms of apparatus for taking autographic records, is alive to the fact that these records are of secondary importance so far as the determination of the properties of the material is concerned, although undoubtedly of great use in exhibiting the nature of these properties. In educational testing especially, as indeed in all laboratory work, there is a danger of fostering too great reliance on autographic records, and the supreme value of first-hand observations cannot be too strongly insisted on.

It must suffice here to mention that the sections of the book which deal with the tests of ropes, chains, struts and so on are sufficient for their purpose, that there is a useful account of cement testing, although perhaps enough weight is not allowed to the personal factor in mixing, and that tests of the other materials of building construction are also briefly dealt with. Some account is also given of the effect of varying conditions, such as temperature, annealing, and bending, on the properties of metals. The effect of repeated stress and of reversed stress is dealt with in Chapter xi., and it would add considerably to the practical value of this chapter if a description of some of the standard pieces of apparatus used in making these tests were included. The account of timber testing is somewhat brief, but the general course of such tests is described and some standard determinations are quoted.

In his final chapter Mr. Popplewell has collected and tabulated a large number of determinations of what he calls the strength properties of the various materials considered, and this chapter, which seems both comprehensive and up to date, will undoubtedly be much used for reference by all who have occasion to consider these properties. He also adds a bibliography of books and memoirs.

We find no reference to the microscopic investigation of the structure of metals, a subject which has so much advanced of late years. The subject, indeed, demands a volume to itself, and at present perhaps is more in the province of the metallurgist than in that of the engineer, but its application to the investigation of flaws in structural parts has already given it a practical bearing which ought not to be overlooked.

Throughout the whole volume the need of occasional calibration of any testing machine in ordinary use is not indicated, nor is any description of the methods usually adopted in carrying out such a calibration given. This is a matter of such importance from a practical point of view that we must attribute the omission to inadvertence, and it will no doubt be rectified in another edition. On the whole, notwithstanding the few omissions and defects to which we have thought it necessary to call attention, we heartily commend the book to all who have to do either with the commercial testing of materials or with the management of the testing departments of engineering laboratories.

A NEW SURVEYING INSTRUMENT.

Der Hammer-Fennel'sche Tachymeter-Theodolit und die Tachymeter-kippregel zur unmittelbaren Lattenablesung von Horizontaldistanz und Höhenunterschied. Von Dr. E. Hammer, Professor an der K. Technischen Hochschule in Stuttgart. Mit 16 Figuren im Text und 2 Lithographierten Tafeln. Pp. 52. (Stuttgart: Konrad Wittwer, 1901.)

PROF. HAMMER has long occupied himself with the problem of constructing an instrument which should give the surveyor the necessary data for plotting his work with the least possible difficulty. Indeed, his numerous references to his previous work, and to the criticisms he has from time to time offered on the work of others, make his introduction not a little difficult to read. But, since the history of his work connected with tacheometers is set out with true German completeness, it may be valuable to anyone who is working on similar lines. In 1893 the author began to solve the following problem: to devise a tacheometer-theodolite, by which at one operation and without reading an altitude circle the observer could determine both the horizontal distance and the difference of altitude of a selected spot from the instrument. This problem the author now claims to have satisfactorily solved, and the instrument is on the market; but notwithstanding this long preparation we gather that several small improvements touching the arrangement of the microscopes and the general mounting of the instrument are still contemplated.

The optical part of the instrument consists of a so-called Porro object-glass, in which two lenses are kept at a constant distance from each other. The principal object-glass has a focal length of 350 mm., and the second lens, placed at a distance of 340 mm., 220 mm., giving to the entire system a focal length of 335 mm. The focussing is effected by moving the object-glass, and the eyepiece views a diagram of peculiar construction on which the effectiveness of the instrument depends. No compass or altitude circle is furnished with the tacheometer, but these can be added if it is desired to use the instrument as a transit theodolite or for other purposes. Instead of an altitude circle, a prism is placed at the side of the telescope above the axis, in connection with which is a carefully constructed diagram, arranged to a scale, by which can be shown the amount of tilting given to the telescope. A second prism placed behind the ocular throws an image of the diagram into the field of view, and as the telescope is moved up or down the diagram is moved to the right or left of the field, thus causing the lines of the diagram indicating the amount of inclination to cut the vertical wire in the eyepiece at a different place. The diagram and mechanical adjustments are so arranged that by multiplying the observed displacement of the line from the zero by 20, the difference of altitude in metres will result, while another displacement multiplied by 100 gives the distance. Very great care seems to have been bestowed on the construction of the field diagram on which the accuracy of the instrument must much depend. The correctness of the coefficient could no doubt be effectually checked by the measurement of known distances and of differences of altitude. Some little inconvenience, it would seem, must arise from the

fact that the zero of altitude does not correspond with the axis of collimation of the telescope. This displacement of the zero line has been necessitated by the desire to make the instrument available for the measurement of differences of altitude amounting to 30°, and to get the resulting displacement for such elevation it was necessary to use more than the semidiameter of the field. The author discusses the amount of error likely to arise from this cause and puts the result in a tabular form. Very full descriptions of the method of adjustment are given and some very practical remarks are made on the method of using the apparatus.

To judge by the examples that the author has given, the instrument should prove very useful in the hands of an expert. These examples show that in the measurement of a distance of 250 m. an error of about 0·6 m. may be apparent, while the average error in elevation over the same distance, and in which the variation of level amounts to about ± 7°, will amount to a few centimetres.

OUR BOOK SHELF.

Results of Meteorological Observations made at the Radcliffe Observatory, Oxford, in the eight years 1892–99. Edited by Arthur A. Rambaut, M.A. (Dubl. and Oxon.), Sc.D., F.R.S., Radcliffe Observer. Vol. xlviii. Pp. xxiv + 245. (Oxford: J. Parker, 1901.)

THE publication of a collection of meteorological observations made in 1892 may at first sight appear somewhat belated, and as giving promise of but little interest. But observations such as the greater part of those contained in this volume serve two purposes. There is first of all the immediate application of knowledge concerning the atmospheric variations whose usefulness is shown in weather prediction and similar purposes. Some may think that this is the main, if not the only, outcome of meteorological inquiry. But, apart from all ephemeral interests, the maintenance of a continuous record of the behaviour of the atmosphere is of great importance. The study of climatic oscillations throughout long periods is a study that is likely to be attended with great advantage and instruction. The long, costly and laborious series of observations, that are so carefully prosecuted at so many stations, can only be justified by their use in investigations which aim at the primary causes of atmospheric disturbance. The records of the Radcliffe Observatory hold a deservedly high place in such series, both for accuracy and for length of time during which they have been uninterruptedly pursued, and for the purposes of scientific meteorology the value of the present volume is undiminished by the length of time that separates us from the earlier observations. It will take its place among many worthy companions and hand on the history of the variation of climate to those who have the skill to read it.

A feature of great additional interest is given to the present volume by an inquiry into underground temperatures at various depths by means of platinum-resistance thermometers. This inquiry was originated under the direction of the late Mr. E. J. Stone, and has been vigorously prosecuted by the present director. The thermometers are placed at depths varying from six inches to ten feet; a greater depth, which was originally contemplated, being found impracticable owing to the presence of water in the soil. The present inquiry is limited, but precise. It concerns itself with the variation of temperature in dry gravel; and the thermal conductivity of a water-logged stratum, or of one greatly differing in constitution from that here investigated, does not come into consideration. The main conclusion to which the Radcliffe Observer is led in this investigation into the physics of the earth's crust is, that the annual variation of temperature is reduced to 0°·1 F. at a depth of 45·3 English feet, and to 0°·01 F. at 66 English feet. The semi-annual wave has the same limits at 21·4 and 36 feet, respectively. The temperature curves for the separate months of the year on which this result is based are shown graphically in a plate possessing many features of interest.

But of equal, if not of greater, importance is the inquiry into the accuracy of the thermometers themselves and their suitability for such investigations. One gathers that although very considerable difficulty was experienced at the outset, and not unnaturally with a novel kind of apparatus, these thermometers have stood the test with great satisfaction and proved themselves more trustworthy and more convenient than the long-stemmed spirit thermometers ordinarily employed in similar researches, and against which some obvious objections can be urged The main difficulty in the use of the platinum-resistance thermometer seems to arise from a damp atmosphere affecting the connecting wires and impairing the insulation, but with sufficient precaution the recording apparatus is most sensitive and permanent.

The Telephone System of the British Post Office. By T. E. Herbert. Pp. xi + 218. (London: Whittaker and Co., 1901.) Price 3*s.* 6*d.*

MR. T. E. HERBERT describes the book before us as a practical handbook, and, from certain expressions used in the second chapter, he seems to be one of those practicians who have not overmuch sympathy with theoretical workers. It is not perhaps to be wondered at, therefore, if the preliminary chapters of his book, dealing with the fundamental principles of sound, electricity, magnetism, and telephony are handled in a very unsatisfactory manner. We are afraid that a reader, if he has not already acquired a thorough knowledge of the subject, will be liable to form erroneous impressions. Thus, to give one example, Mr. Herbert states that in an induction coil "the E.M.F.'s generated in the secondary coil are directly proportional to the current variations in the primary." Again, the description of the action of the Bell transmitter is, we are inclined to think, incorrect, as the same mistake is made here of not properly allowing for the time taken over a vibration of the diaphragm.

The greater part of the book is devoted to a detailed consideration of the apparatus and connections used by the Post Office. This would have been greatly improved if more care had been taken with the diagrams. It is a great pity that in a book of this kind, where clearness in the illustrations is so important, the lettering should be in some cases so small as to be unreadable. It is to be regretted, too, that such words as "nextly" and "inoxidible" are allowed places in the text. In spite of the defects, some of which we have tried to point out above, we have no doubt the book may prove useful to telephone engineers who are anxious to be helped over some of their practical difficulties, and are not particular about a clear understanding of the groundwork of their science.

Maps: their Uses and Construction. A Short Popular Treatise on the Advantages and Defects of Maps on Various Projections, followed by an Outline of the Principles involved in their Construction. By G. James Morrison, Memb. Inst.C.E., F.R.G.S. Pp. viii + 110. (London: Edward Stanford, 1901.) Price 5*s.* net.

A BOOK in English on map projections has long been needed, and the present work is a very welcome attempt to meet this need. It may be commended to all who have to deal with geographical questions, and to teachers of mathemathics and practical geometry who wish to find fresh exercises for their pupils.

The volume consists of an introduction, a popular account of eight common projections, followed by another